

OBSERVATIONS ON THE OVIPOSITION AND HABITS
OF CERTAIN AUSTRALIAN BATRACHIANS.

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The object of my remarks is suggested by the following quotation from a paper by Dr. Günther: "Our knowledge of the mode of propagation of extra-European Batrachians is restricted to a very small number of species; and from the few singular facts with which we have become acquainted, we may expect that most interesting discoveries will be made by naturalists who have the opportunity of observing these animals in their native countries." *

The late Mr. Krefft at different times published three lists of Australian Frogs, † and one of those found in the neighbourhood of Sydney; ‡ several of these—as well as a paper "On the Vertebrated Animals of the Lower Murray" &c. §—contain particulars about the habits of Australian frogs, and in one or two of them the subject of their breeding is incidentally but very briefly touched upon. Dr. Günther has also recorded some observations || on four species of Australian frogs—three of which are figured—which lived for some time in the Zoological Gardens, London; and Professor McCoy ¶ has some remarks on *Hyla*

* Ann. Mag. Nat. Hist. 1876 (4), xvii, p. 377.

† (1) Cat. of Nat. and Indust. Products of N.S.W. forwarded to the Paris Universal Exhib. of 1867, p. 107.

(2) Monthly Not. of Pap. and Proc. Roy. Soc. of Tasmania, 1865, p. 16.

(3) "Australian Vertebrata." *The Industrial Progress of N.S.W., being a Report of the Intercolonial Exhibition of 1870, at Sydney*, p. 741.

‡ P.Z.S. 1863, p. 386.

§ Trans. Phil. Soc. of N.S.W. 1862-65, p. 32.

|| P.Z.S. 1863, p. 249.

¶ Prodromus of the Zoology of Victoria, Decades v and vi, pl. 42 and 53.

aurea, *Limnodynastes dorsalis*, and *L. tasmaniensis* to accompany coloured plates of these species. These, together with the notes of Messrs. Aitken and Sanger (*infra* p. 361) I believe, comprise all but what relate to the taxonomy of Australian Batrachians.

The species of frogs referred to in what follows are, with one exception, comprised in the Batrachian fauna of the neighbourhood of Sydney, or, as it would be better to say, of the County of Cumberland, a district which, with an average rainfall of 50 inches, is, for Australia, one very favourable to Batrachian life. It is necessary to point this out because Australia presents such a wide range of climate, and many of the species are more or less cosmopolitan; hence it may be that individuals of the same species may present differences in habits according to locality and variations in external conditions, and more particularly rainfall.

Reference to Boulenger's "Catalogue of the Batrachia Salientia in the British Museum" (1882) shows about fifty species to be therein recorded from Australia and Tasmania, while last year the same gentleman described two additional species; of these New South Wales may be credited with about thirty, and the County of Cumberland with about twenty. This number suffices to show how rich in Batrachians the neighbourhood of Sydney is, though owing to the steadily increasing area required for settlement, the consequent removal of sheltering logs and stones, the contamination of the ponds and creeks with sewage, and the increasing numbers of ducks, geese, and small boys, the collector of frogs already has to lament the devastation of some of the best collecting grounds in the neighbourhood. Though other local lists are not so far available, yet as many of the species are more or less cosmopolitan, and each of the colonies has one or more peculiar species, Australians may well be astonished at the following ridiculous statement, more especially as it is made by so eminent a scientific man as the late Paul Bert: "In our country the poor toads are often cruelly and stupidly destroyed. It will undoubtedly not a little astonish you to hear that great

numbers of these useful but disregarded creatures are sent from Europe to Australia to help to keep the gardens free from noxious and destructive guests, such as snails, insects, &c.*

Of the frogs occurring in this neighbourhood then I have at different times found pairs referable to about ten species *in coitu*, and in most cases have been able to identify the ova, and to determine the circumstances under which oviposition takes place. The species referred to are *Limnodynastes tasmaniensis*, *L. dorsalis*, *Crinia signifera*, *Hyla aurea*, *H. ewingii* var. *calliscelis*, *H. phyllochroa*, *H. citropus*, *Hyperolia marmorata*, *Pseudophryne australis*, and *P. bibronii*. With the exception of the two species of *Pseudophryne* (and perhaps, though I doubt it, also *Hyperolia marmorata*, of which I have seen the ova, but only when laid under abnormal conditions) these come under Section A. of Group I of Mr. Boulenger's Synoptic Table,† that is to say:—

i. "The ovum is small and the larva leaves it in a comparatively early embryonic condition."

A. "The ova are laid in water."

"Probably the majority of Batrachians; all European forms except *Alytes*."

In regard to some of the remaining species, by noting the dates on which males with breeding papillæ have been found, or young ones completing their metamorphoses, some idea of the breeding season has been gained; while the occurrence of recognisable tadpoles in ponds which one has been regularly in the habit of visiting, together with a knowledge of the characters of such ponds and of the facilities which they offer to frogs for depositing ova, enable one to form opinions which will probably eventually be found to approximate to the truth. Hence from such incomplete observations as I have been able to make I think that by far the majority of the remaining species occurring in the County of Cumberland also deposit their ova in water in the ordinary

* "First Year of Scientific Knowledge." By Paul Bert. English Edition translated by Madame Bert (1886), p. 61.

†Ann. Mag. Nat. Hist. 1886 (5), xvii, p. 463.

way without presenting anything remarkable. At any rate, with the exception of the ova of the two species of *Pseudophryne* above-mentioned, no spawn has been met with by me except such as has the characters mentioned. In the case of a few of the rarer species, or those which do not occur very near Sydney, e.g., *Hyla latopalmata*, *H. lesueurii*, *H. dentata*, *Hylella bicolor*, no data whatever have so far been obtained.

The two species of *Pseudophryne* do not oviposit in water, but under stones, &c., in damp situations. The tadpoles, though capable of sustaining without injury a prolonged postponement of the hatching—in one case for a period of over three months,—seem unable to complete their metamorphoses without gaining access to water. These two species therefore are referable to Group II of Mr. Boulenger's Table, and will be provided for if Section A of it be subdivided as follows:—

ii. "The yolk-sac is very large, and the young undergoes the whole or part of the metamorphosis within the egg; at any rate the larva does not assume an independent existence until after the loss of the external gills."

A. "The ova are deposited in damp situations or on leaves."

(a) The embryo leaves the egg in the tadpole stage.

Pseudophryne australis, Gr.; *P. bibronii*, Gthr.

(b) "The embryo leaves the egg in the perfect air-breathing form."

"*Rana opisthodon*, Blgr.; *Hylodes martinicensis*, D. & B."

Other Australian frogs, more particularly *Myobatrachus gouldii*, Gr., (sp.) from West, and *Notaden bennettii*, Gthr., from East Australia, perhaps also *Helioporus albopunctatus*, Gr., may be expected to exhibit similar or perhaps even more interesting modifications. In his description of the first-mentioned of these Dr. Günther alludes to the large size and the fewness of the ova.* *Notaden* is an inland form, recorded in the British Museum Catalogue from Castlereagh River, also from Wilson's River, Queensland; but this species also occurs in the Cobar and Narrabri districts, the

*"The eggs are very large, half the size of a pea, and there are only twenty to twenty-four in one ovarium; no sign of an embryo is visible therein, although the eggs appear to be ripe for being laid." (*Cat. of Batr. Sal. in the Brit. Mus.*, first edition, p. 54).

former of which has (for a period of six years) a mean annual rainfall of 13·66 inches, and 45 as the mean annual number of rainy days, as compared with 49·86 inches and 153 days respectively for Sydney (for 29 years).* Hence in such a locality as this the frogs must sometimes be in great straits to get rid of their ova, if their oviposition is of the ordinary character; and the young must often develop under difficulties unless there is some adaptation to circumstances. Dr. Günther (l.c. p. 378) also says: "The observation of A. W. Aitken (*Trans. New Zeal. Inst.* ii. 1870, p. 87) that in tropical parts of Australia certain frogs form a hollow ball of clay, containing about half a pint of clear cold water, in which they sojourn during the drought, is probably also indicative of a provision to secure the safety of the spawn and young." Further information about this species as well as its identification are desirable. Mr. E. B. Sanger states† that on one occasion he found in pools collected from rain which had fallen two days previously, "the first time for certainly two years," on the stony plains of the central Australian desert, a great number of tadpoles and a young fish; and as to how they came there he concludes "that the eggs must have been buried rather deeply, and then when the moisture reached them developed rapidly." On this subject Mr. Aitken also says (l.c.) "There are districts often exceeding 5,000 square miles in extent in the interior of the Australian continent in which there is no surface water for many months, and in some instances for years; yet as soon as rain falls in sufficient quantities to fill the water-holes they are swarming with young frogs." Further on he again speaks of swarms of tadpoles peopling the water-holes after rain.

Since 1881 I have carefully made notes of the dates at, and the circumstances under which, I have met with frogs breeding; with the result that, taking one year with another for several years, *e.g.* the three years 1884-86, some frog-spawn was met with in every month in the calendar. Not that there was anything abnormal about these years, for a similar result would be quite normally obtainable by regularly collating one's observations for

* "Rain and River Observations, 1887, p. 41."

† *American Naturalist*, 1883, xvii. p. 1185.

a longer or shorter period. This interesting state of things—in correspondence with which the creeks and ponds, except of course during such unfavourable seasons as we have recently had when these have had little or no chance of becoming established, may be found more or less teeming with tadpoles throughout the year—is attributable to at least three or four causes:—(1) Dependence of the oviposition on the rainfall, itself irregular; (2) Seasonal differences in the breeding times of different species; (3) The prolongation of the breeding seasons owing to the fact that all the females of a given species may be far from simultaneously ready to spawn at a given time; and possibly (4) some species may breed normally more than once during the year. The mild climate is perhaps also a factor which should not be entirely overlooked.

The rainfall is a most important factor in regulating the dates of oviposition, inasmuch as a heavy downpour of rain is often necessary to release the frogs from their æstivation, and in many cases to provide the water-supply in which the spawn is to be deposited. A heavy downpour of rain succeeding a period of dry weather will set some frogs spawning at any time of the year; and on the other hand, in whatever month the frogs spawn, as a general rule they do so as soon as the weather clears up after rain. In the case of the swamp frogs, if, as in very favourable years, the ponds are full when the frogs are ready to spawn, no doubt they do so; but in very dry seasons they are in the same plight as the less aquatic species.

In England *Rana temporaria* spawns with considerable regularity at the end of February or beginning of March, the spawning lasting about a fortnight; while on the continent two varieties of *R. esculenta* spawn within a fortnight of each other, a fact which is held to be of importance as indicating that they are distinct races, and in maintaining their distinctness.* Similar regularity has been noted in the case of American frogs.† With our frogs there is much irregularity, and the ovipositing periods, instead of

* P.Z.S. 1885, p. 670.

† Packard's "Zoology" pp. 484-487,

being brief and well-marked, are more or less prolonged and intermittent, a condition for which the irregular character of the rainfall is primarily and mainly responsible. Of a period of thirty years the Government Astronomer says:—"There is not much difference in the average amount of rain falling in each of the first seven months, but a marked decrease is manifested in the last five, especially September, November, and December. . . . It is remarkable that during that period every month in the calendar, except December, has been the maximum for the year one or more times. . . . The evaporation in October, November, December, and January is greater than in the other eight months of the year." (Meteorology of N.S.W. Industrial Progress of N.S.W., 1871, pp. 589, 590).

That is to say at the season of the year at which it would seem most natural for the frogs to spawn, judging from the habits of frogs in general, the meteorological conditions on the whole are against them, for, even allowing for averages, the monthly rainfall is decreasing, the evaporation is on the increase, so that spring-droughts are by no means uncommon; this state of things is varied occasionally by a very heavy rain-storm during this period giving the maximum monthly rainfall for the year, an event which gives the frogs special opportunity.

In the case of *Rana temporaria*, for example, all the surviving frogs of the same season's hatching are approximately of the same age, while all the frogs of different ages differ in regard to the same by some multiple of one year. With our frogs this may obviously not be the case, since individuals of the same species hatched during the same season may differ in age by as much as six months or more; so that it is reasonable to expect that the maturation of the ova, though probably occurring at regular periods, should not be simultaneous in all the females of a given species. Consequently of our frogs it may be said that they spawn when they are ready, or as nearly as the conditions of moisture will allow; but that they are not all ready at the same time.

In correspondence with this one never sees as much spawn at any one time as may be seen in an English pond when the frogs are breeding. My most instructive round in one of the suburbs of Sydney included a visit to an old quarry, a brick-yard, a deserted tan-yard, and three waterholes in paddocks used for watering cattle; these five spots were frequented during some period of the year by at least eleven species of frogs. If during a visit to these on the same afternoon in the whole of the ponds together between 100 and 200 individual deposits of spawn could be counted, I should consider it a very brisk outburst of spawning. And one might make this same round after every heavy downpour of rain throughout the year and find more or less spawn as described. But for the "gallons of jelly" which may be seen in English and American ponds* when the frogs are breeding, one looks in vain out here.

There are also indications of seasonal differences in the breeding periods of different species, respecting which further details are given later on.

Mr. Krefft says: "During the breeding season, however (about November), many otherwise nocturnal frogs may be seen in broad daylight in search of their mates. . . . The greater number of species have deposited their ova in the beginning of December, though I have reason to believe that some species breed at all seasons, for I have taken *Pseudophryne australis* in mid-winter full of ova, and have observed larvæ of this and of several other species in pools of water about the same time. All the Hylidæ, however, deposit their ova only once a year, generally in November and December" (l.c. No. 2, p. 19). On the whole the breeding period is shorter and perhaps better marked in the majority of the Hylidæ which may be said to spawn during the latter half of spring, and summer, certainly both earlier and later than Mr. Krefft mentions; *Hyla ewingii* var. *calliscelis*, on the other hand, is a remarkable exception. As far as my observation goes, *Pseudophryne australis* may be fairly said to spawn during summer, and

* "Wake Robin," by John Burroughs, (English edition) p. 181.

P. bibronii during autumn. Whether some species do not also spawn more than once in the year is very probable, but it is a difficult matter to decide. If this is not the case with some of them then these might almost be said to "breed at all seasons." The species of *Limnodynastes*, however, should be excluded, as though their breeding season is long enough to give them the opportunity of spawning at least once in half-a-year, yet there is a well-marked though perhaps not very long period in winter (say two months or longer or shorter according to circumstances) during which heavy rain neither sets them croaking nor breeding, though in the interval *Crinia signifera*, and *Hyla ewingii* var. *calliscelis* may be breeding and lustily vocal.

Characters of the spawn.—All the spawn observed by me has been (1) white frothy-looking more or less circular floating patches, larger or smaller according to the species, deposited in the water; or (2) small submerged bunches of ova enclosed in clear transparent jelly attached to blades of grass or reeds, or twigs of dead branches, or (3) numerous separate ova not laid in the water but under stones, or débris in reed or grass tussocks on the edges of pools.

The first section includes the spawn deposited by *Limnodynastes tasmaniensis*, *L. peronii*, *L. dorsalis*, and *Hyla aurea*; probably also that of *H. citropus*, *H. caerulea*, *H. peronii*, *H. freycineti* and others. The floating patches when fresh are more or less circular if free, isolated or often in corners or behind a particularly good bit of shelter the spawn of a few contiguous spawning couples accidentally coalescent, conspicuous from the white colour, and look very much like the froth of soap-suds. If there is no wind they may continue to float freely; otherwise they become adherent to the bank, or anything else with which they come in contact, by the sticky and tenacious gelatinous substance enclosing the ova, or they may have become so from the first where laid. *Limnodynastes tasmaniensis* is very fond of spawning in ditches close to the bank under overhanging ledges. Sometimes the ova are deposited in the middle of a bunch of reeds or grass to which the patches are anchored from the first, or about the bases of tussocks; in many

cases the surface of the water being lowered subsequently by evaporation or otherwise, such patches may soon be left high and dry with little chance of developing. The frothy appearance of the patches is caused by the entanglement of numerous bubbles of air or gas in the glairy envelopes of the ova, and their accumulation on the surface, quite obscuring the ova which to the number of several hundred lie below. The oviposition of the common European frogs is said to take place at the bottom of the water, the ova being subsequently floated to the surface by the disengagement of gas in the substance of the glairy envelopes (the hatching in England not taking place for a month). The frothy appearance of the spawn of our frogs is hardly I think to be explained in this way. In shallow pools they may be said to oviposit at the bottom of the water—and in many cases, though it may be only accidental, it seems as if the frogs preferred to oviposit in shallow water an inch or two in depth, *e.g.*, in rain pools, or in a chain of little pools along the course of overflow of a pond, or in the water-tables of roads, and which often dry up in a few days' time without the tadpoles having a chance of surviving, and this though more permanent supplies of water may be close at hand; or round the edges of large ponds. But on the other hand, whether from choice or necessity, frogs certainly do spawn sometimes in deeper water, and then the copulating frogs may be seen floating at the surface, or clinging to the branches of partially submerged shrubs, and they evidently spawn so. Moreover such frothy patches enclosing the still segmenting ova, and sticky enough to adhere readily to anything stationary with which they may come in contact, may be found floating freely; and by visiting a pond in the evening and then again in the early morning, one may satisfy oneself as to some of its having been deposited during the preceding night, even if one cannot get more direct evidence. Hence it seems to me that the buoyancy of the patches is possibly quite as much dependent on the entanglement of air-bubbles due to oviposition at or close to the surface of the water, or perhaps to some peculiarity in the mode of oviposition, as to the liberation of gases by decomposition in so short a period, more especially as in our mild climate the tadpoles are hatched by

about the fourth or fifth day (longer if the weather is very cool), the patches in the meantime spreading out and becoming larger but losing their frothy appearance and showing signs of disintegration. The spawn referred to the next section also is without the frothy character, even when not attached to twigs &c. as sometimes accidentally happens. At the same time it must also be pointed out that in all the cases in which *L. tasmaniensis*, and *H. aurea* spawned in dishes of water in captivity the spawn was without the frothy appearance; but the very unnatural conditions of the surroundings and circumstances probably will explain this.

Such spawn may be found intermittently from about the middle of July to the following April or May, sparingly at the beginning and end of the season. If the conditions are favourable a good deal of spawn may be met with in August, and again towards the end of September or beginning of October or thereabouts; if however there is a spring drought then vigorous spawning may be looked for about the middle of January, when heavy showers accompanying thunderstorms may be expected. The ova are small and numerous, and so far as I have seen have the pigmented pole very dark, dark brown or blackish or even black, the unpigmented portion being white or whitish, or slightly tinged with a dark wash, about 1-1.5mm. in diameter.

The second section includes the spawn of *Crinia signifera*, *Hyla ewingii* var. *calliscelis*, and *H. phyllochroa*; probably also *H. krefftii* and other small species. This kind of spawn in inconspicuous bunches of 1-2 inches long is symmetrically disposed round grass- or reed-stalks or twigs, so that the spawn remains submerged just below the surface of the water, very much as described in certain American species. There are about 100 ova in a bunch, enclosed in clear jelly; and from the small number of ova, and the slender nature of the supports, one would expect them to have been deposited by small frogs. The ova of *Crinia signifera* have the pigmented pole black, the rest of the ovum being white; of *C. ewingii* var. *calliscelis* orange and pale

yellowish; and of *H. phyllochroa* yellow, the lower pole slightly tinged with yellow. Exceptionally one may see this kind of spawn floating free, or attached otherwise than as described; but this is probably accidental or due to the absence of grass-stalks or twigs. The spawn of this section may be met with under favourable conditions at almost any time of the year; even in mid-winter.

The third section includes the spawn of *Pseudophryne australis* and *P. bibronii*, already referred to, which may be found during summer and autumn. (For further details see p. 376.)

During copulation the males in some species clasp under the arms, in others round the waist; thus the embrace is axillary in *Mixophyes fasciolatus*, *H. aurea*, *H. citropus*, *H. ewingii* var. *calliscelis*, *H. phyllochroa*, and *H. cerulea*; it is inguinal in *Limnodynastes tasmaniensis*, *Hyperolia marmorata*, *Crinia signifera*, *Pseudophryne australis*, and *P. bibronii*. In a footnote to his description of *Limnodynastes ornatus* Mr. Boulenger says (l.c. p. 262) "that one of the females of this species has on the breast two cicatrices which are evidently caused by the thumbs of the male; this proves that the male seizes the female under the axillæ and not round the waist." In *L. tasmaniensis*, as I have had ample opportunity of observing, the embrace is inguinal as stated above. I have had only a single and early opportunity of observing the *coitus* in *L. dorsalis* and *L. peronii*, when I was not sufficiently alive to the desirability of noting the mode of embrace, and I regret to say that I have never had the chance since of repeating the observation; hence I am unable to speak with confidence in the case of these two species.

The tadpoles of the different species in their earlier stages offer few characters sufficient for their identification—unless perhaps a study of those of the mouth with its horny fringes would yield such. As the completion of the metamorphosis approaches, however, the determination becomes less difficult, the characters of the webbing, or of the metatarsal tubercles, or of the disks when the hind limbs have developed, being among the earliest satisfactorily recognisable

characters. The tadpoles of *H. aurea* and *H. cærulea*, at any rate in their later stages, are green, in the case of the former the larval frogs acquiring golden streaks before leaving the water. I have no definite information as to the length of time which elapses under favourable conditions between the hatching and the completion of the metamorphosis in the case of any species.

For some three months commencing about May, or for a period longer or shorter, or commencing or ending earlier or later, according as the weather is very mild and the season favourable or otherwise, the frogs, like the snakes and lizards, resort to the shelter of logs and stones, under which they are then to be met with in a more or less sleepy condition. It is also noticeable how frequently frogs which at other seasons frequent gullies or swamps, are at this time found on high ground, on the slopes or summits of the ridges, and long distances from water. In this mild climate where the ground is never frozen the hibernation does not seem to be of the thorough-going character exhibited by frogs in Europe and America, which are said to bury themselves in the mud at the bottom of pools, lying clustered together in a state of complete torpidity.* Australian frogs may also hibernate in this way (*L. dorsalis* possibly; Mr. Krefft says also many individuals of *H. aurea*); but seeing how abundant they are in the situations indicated during this period as compared with other seasons of the year, it is evident at least that the habit is by no means universal; and moreover some species like *Hyperolia marmorata* one rarely sees during the rest of the year. Semper in his "Animal Life" (p. 426, Note 36) quotes Forel's view "that winter-sleep does not depend at all on the diminished temperature in winter, but rather on influences determined by food." How far the hibernation of our frogs is due to chill-coma, and how far to scarcity of food I am not

* Article "Frog," Encyclo. Britann. ix, 794. On the subject of the hibernation of American frogs *vide* Butler in Report Amer. Assoc. Advanc. of Sc. xxxiii, p. 545. and Amer. Nat. 1885, p. 37.

prepared to say; but seeing that some of the small frogs actually breed in mid-winter, one cannot help wondering whether if food were more abundant during the cold months, the period of hibernation would be as well-marked as it is. Certainly the species differ among themselves in certain respects. For example the larger species are silent during this period, but as early about the middle of July if the weather is mild *Limnodynastes tasmaniensis* may be heard and be found to be breeding, whereas this will not be the case with *Hyla aurea* until about the end of September, or a little later, and later still for *H. cærulea* and *H. peronii*. On the other hand *H. ewingii* var. *calliscelis*, and *Crinia signifera* may be heard croaking and even breeding after rain in mid-winter, though these species are to be found apparently sheltering under stones, &c., like the others.

That our frogs æstivate during hot and very dry periods there can be no doubt; in many cases they must certainly otherwise perish. During such times one hears no croaking and sees very little or nothing of the frogs; while logs and stones no longer afford sufficiently moist shelter. In March 1885, a very dry month, after just sufficient rain to moisten the ground, hearing croaks emanating from what under more favourable conditions is the bed of a pond, I turned up the soil with a stick and soon unearthed half a dozen specimens of *Pseudophryne bibronii*, which were in this manner trying to survive the drought.

Speaking of the Batrachia of Victoria, Professor McCoy says "with the exception of the common green frog (*Ranhyla aurea*) [they] are rarely seen or heard,—the true tree-frogs (*Hyla*) inhabiting the lofty gum-trees, and the *Limnodynastes tasmanicus*, *L. dorsalis*, and *L. affinis* burrowing in the sand during the day."* This statement will not apply to the Batrachians of this neighbourhood except perhaps during a drought. It is quite true that nocturnal frogs like the species of *Limnodynastes* and *Pseudophryne* are not seen or heard in the day-time except when breed-

* Ann. Mag. Nat. Hist. (3) xx, 1867, p. 182.

ing; but besides *H. aurea*, one may see *H. freycineti*, *H. latopalmata*, *H. phyllochroa*, *H. lesueurii*, *H. citropus*, and *Mixophyes fasciolatus* abroad by day, and *H. cærulea* frequently comes into verandahs and even indoors in the summer evenings: while as for hearing the frogs, in the evenings in October and later after rain in the western suburbs of Sydney wherever there are paddocks and waterholes, one may hear the croaking of individuals belonging to at least half-a-dozen species in the course of as many minutes; indeed the frogs of some species may be heard at any time of year in moist weather. *L. dorsalis* is rarely seen probably owing to its habit of burrowing which I believe Professor McCoy was the first to point out; but *L. tasmaniensis* and *L. peronii* are so commonly to be found sheltering under logs and stones that, except during periods of æstivation, one may doubt whether in this locality they habitually burrow. With regard to the statement that the true *Hylas* inhabit the lofty gum-trees—a similar supposition in regard to *H. citropus* in the summer being made by Mr. Krefft—one may remark that no evidence in favour of it is adduced in either case; indeed direct evidence would be very difficult to obtain. The most arboreal of the Hylidæ in this neighbourhood may be found on the ground during the cold months, and during the summer they come to the ground to breed, as they doubtless do also to æstivate. It is quite true that *Hylas* may often be found sheltering under the loose bark on the trunks of trees, but there is no other evidence forthcoming at present of the frogs in this neighbourhood habitually inhabiting lofty trees unless it be that some of them are not so frequently met with during part of the year. Professor Cope remarks of our Hylidæ “that in the latter country (Australia) with its usual perverseness they are terrestrial in their habits.”* I think it would not be an altogether unreasonable supposition that the addiction to terrestrial habits, which more particularly characterises the species formerly included in *Litoria*—now along with *Pelodryas* merged in *Hyla* by Boulenger—is to be explained as in part due to the frequently arising necessity of finding more

* Nat. Hist. Rev. 1865, p. 109.

moist shelter during very dry periods than could be found under loose bark, &c., on trees. On the other hand, *Hyla aurea* which is pre-eminently a swamp frog, may often be seen basking on the trunks or branches of trees which have fallen into or across ponds; while in other situations it is still more arboreal. In Mr. Macleay's bush-house there are generally some of these frogs, which may often be seen perched on the tree-ferns or plants. In March, 1887, Mr. Masters called my attention to a still better instance in which several of the frogs were perched in the asparagus plants preying on the caterpillars and grasshoppers with which at this time of year the asparagus is much infested.

MIXOPHYES FASCIOLATUS, Gthr., is not yet recorded from the County of Cumberland, but it may still be looked for on the side adjoining Illawarra. I am able to record its occurrence at Springwood, and Mt. Wilson, Blue Mts., whereas it was previously known from Clarence River, and Illawarra N.S.W., and Pine Mt. Queensland. From the observation of a single specimen living in captivity Mr. Krefft supposed "that this frog is remarkably fond of lying buried under moss in water, never making its appearance before dark."* Where I have seen it, it is a diurnal frog haunting the banks of creeks in deep shady gullies. It takes readily to the water on being pursued. With an exception or two all my specimens were met with in the open in this way. Two males taken in December, and one in the beginning of April show a large brownish rugosity on the first finger of each hand together with a slight modification on the inner half of each second finger. At the end of December at Mt. Wilson large dark-coloured tadpoles were very numerous in the creeks in the gullies where the frogs were abundant; one of these in spirit with the hind legs about half developed is 61 mm. long including the tail (which is 41 mm.), the breadth of the body being 14 mm. In the beginning of November in the succeeding year the tadpoles were nothing like so noticeably numerous. On April 2, 1888, on opening the tin in which three living specimens of the frogs were brought down alive

* Monthly Notices of Paper and Proceedings Roy. Soc. Tasm. 1865, p. 19.

from Springwood, one male was found to have seized a female, the clasp being axillary; but nothing came of it. Two half-grown specimens obtained at Mt. Wilson at the end of December are 28 and 30 mm. from snout to vent; a third specimen from Springwood at the end of March is 24 mm. These are probably specimens of two seasons' growth. On the whole I should conclude that this species breeds during the summer months and oviposits in water in the ordinary manner.

Mr. Krefft estimated the number of species occurring in the neighbourhood of Sydney as nineteen or twenty, of which in two papers he enumerates seventeen, the others being then undetermined. The thorough revision of the whole group by Mr. Boulenger has rendered Mr. Krefft's lists obsolete, some of the species being now known by different names. It may be convenient therefore to have a revised list of the species occurring in the County of Cumberland, since out of Sydney the opportunities of consulting the British Museum Catalogue are limited. It includes all the species mentioned in the last-named work from the district in question.

Of the following species I have myself collected specimens belonging to eighteen species within the limits of the County of Cumberland, in addition to three others, one (*Hyla lesueurii*) just on the border as well as in the adjacent County of Cook, and two others (*Mixophyes fasciolatus*, and *Cryptotis brevis*) also in the latter county. For the identification of many of my specimens, including all those difficult to determine from mere descriptions, I am indebted to Mr. G. A. Boulenger of the British Museum, to whose courtesy and help I am glad of this opportunity of acknowledging my indebtedness.

CYSTIGNATHIDÆ.

1. LIMNODYNASTES PERONII, D. & B., sp.

Not quite so common as some of the others, and not occurring sufficiently near me to be so conveniently and systematically observed. I have seen breeding specimens only once, in February,

in deep water and out of reach in a quarry. At Burrawang it is the common *Limnodynastes* of the neighbourhood, and I have found numbers hibernating under logs in July, some of them females distended with ova as if the breeding season were not far off. It is quite common to find the very young frogs with bright red or carmine longitudinal stripes on the back, corresponding with the light stripes of the adult, and also on the arms and legs. A spirit specimen 22 mm. from snout to vent still shows them well.

2. LIMNODYNASTES SALMINII, Steind.

Keferstein gives Sydney as a locality for this species; Boulenger's Catalogue also for one half-grown specimen. I have never been able to find it, nor are there specimens of it from nearer than Bathurst in the Macleay Museum

3. LIMNODYNASTES TASMANIENSIS, Gthr.

One of our commonest frogs, and about the earliest of the larger species to be heard croaking and to be found breeding after hibernation, as it is about the last to leave off before this period. A female taken *in coitu* on January 30th spawned the following day; she had a light vertebral line, the male had not. The tadpoles must be very common, but I do not happen to have met with them at a stage of growth in which they were identifiable. As Mr. Krefft observes, the very young frogs often show a distinctly red vertebral line.

4. LIMNODYNASTES DORSALIS, Gr., sp.

Probably not rare, but it manages to keep out of sight, possibly owing to its penchant for burrowing. I have seen one pair *in coitu* late in September; guided by the croak I captured a male in November with well-developed breeding rugosities—a pair on each hand; in February I found three dead ones (probably stoned by boys) with frothy spawn in a pond at Manly; and I have seen a male captured in March, also with breeding rugosities. The breeding season is thus possibly as prolonged as in *L. tasmaniensis*.

The tadpoles are very large—the largest occurring in the neighbourhood. I have seen them in ponds at least as late as June and as early as September. Several which I have measured are from $2\frac{1}{2}$ to nearly 3 inches long, the tail about half as long again as the body. At first they are very dark in colour, almost blackish, but they become lighter as they increase in size, the ground colour becoming brown or olive-brown much spotted with darker spots; they have a single spiraculum on the left side of the body. Two larval frogs with the tail all but absorbed are about 21 mm. from snout to vent. Neither the tadpoles nor the frogs seem to show any of the carmine spots or stripes so commonly present at some stage in other species of the genus.*

5. *CRINIA GEORGIANA*, Bibr., sp.

I have never met with this species which ought to be easily recognisable by its having the “loins, front and hinder side of thighs and inner side of tibiæ carmine.” Mr. Krefft mentions it only in the latest of the four papers referred to, and then as from King George’s Scund, not from Sydney. The latter is given by Dr. Günther (*Ann. Mag. N. H.* (3) xx, p. 53) and in the British Museum Catalogue.

6. *CRINIA SIGNIFERA*, Gir. sp.

One of our commonest species. At Burrawang late in June after three days’ incessant rain during which as many inches fell, hundreds of these tiny frogs in the swamps and creeks began to croak. One much distended female had the oviducts crammed with ova. A few mornings after I found at least fifty deposits of similar ova attached to blades of grass and reeds in a small pond though except on cloudy nights there were sharp frosts and the surface of the pond was frozen over in the mornings. A fortnight later at Capertee (2700 feet) in equally cold weather

* In the young frogs of *L. tasmaniensis* and *L. peronii* as mentioned above; in the adults, probably also in the young, of *L. salminii* and *L. fletcheri*, Blg.; and in the young frogs, and, as I have also reason to think, in the advanced tadpoles of *L. ornatus*.

similar spawn was noticed. About Sydney I have met with it in different years in February, May, and July.

At Mt. Wilson at the end of December I found a pair *in coitu* under a stone near the water. Possibly this species breeds more than once a year.

7. *HYPEROLIA MARMORATA*, Gr., sp.

Common under stones in the cool months. Females distended with ova may be found in June; once early in June a day or two after bringing home some specimens three were observed *in coitu*, a second male clasping the first; of a number of specimens kept in confinement for two months (July and August) two on one occasion in August were noticed *in coitu*, but no ova were deposited in either case. Of three specimens kept for some days in September one female deposited over 200 separate ova in a dry saucer, but they did not develop and probably had not been fertilised. The ova had the pigmented pole black, the other cream-coloured.

8. *HELIOPORUS ALBOPUNCTATUS*, Gr.

Sydney is mentioned as a locality by both Boulenger and Kesterstein. I have never met with it, but have a very large old male specimen in which the shagreening of the skin is more than usually developed, given me by Mr. A. G. Hamilton, whose son found it in a creek-bed at Hartley, Blue Mts.

BUFONIDÆ.

9-10. *PSEUDOPHRYNE AUSTRALIS*, Gr., sp., and *P. BIBRONII*, Gthr.

Mr. Boulenger suggests that the latter may prove to be a mere variety of the former; but this view will not I think commend itself to anyone who is familiar with the frogs in their natural conditions. Not only is there the well-marked and very constant difference in colour and pattern, but the frogs differ more or less in temperament, in habits, and in regard to the breeding season.

P. australis is a lively perky little frog, very partial to damp shelves and cracks in the Hawkesbury sandstones; and breeds earlier—three times I have found ova, in November, January, and this year as late as May 11th, but early in September I once saw a pair *in coitu*, though I do not know that spawn was deposited. *P. bibronii* on the other hand is much less active, usually makes little or no effort to escape when uncovered in its hiding place, “shams dead” when placed on its back, and falls to the bottom like a stone when thrown into water; I have never found it except on the ground under stones, logs &c.; I have found the ova every year for seven consecutive years, once in April only, thrice in May only, once in June only, and twice in both April and June.

The two species agree in regard to their oviposition and general development. The ova are laid after rain in depressions or cavities, preferably under stones, but when these are wanting under pieces of old tin, under débris brought down by the water, or in a tussock of grass or reeds, near the margins of ponds or creeks. That they have been deposited where one finds them is obvious from the circumstances under which they occur. To satisfy myself that the ova could be fertilised without being placed in water I collected at different times males and females of both species. In two instances on reaching home at least one couple were *in copula*, the embrace being inguinal; these subsequently spawned on a damp rag placed at the bottom of a dish, the ova as shown by their subsequent development being duly fertilised. Several hundred ova may sometimes be found in the same little cavity, but these have been deposited by several females. In the two instances above-mentioned each frog laid about ninety ova; and these were disposed in short rows or in masses of a dozen or more, at some distance apart, showing that the frogs had moved some distance every now and then and probably slightly after the deposition of each ovum. The ova would seem to be fertilised singly. If the surroundings are moist the ova, (including the gelatinous envelope,) are about as big as peas,

spherical, 3-5 mm. in diameter; if in contact they adhere to one another slightly but are readily separable with a feather, and do not fuse into a mass. The ova themselves are twice the size of ordinary frog ova.

The pigmented pole is black, the other cloudy white. The segmentation is complete, but on account of the considerable amount of food-yolk very irregular; the pigmented pole segments much more rapidly than the other; and in some segmenting ova which I observed, after the stage in which there were two vertical and one transverse furrow the next two vertical furrows instead of continuing round the lower pole frequently turned to one side and joined one of the original vertical furrows. As I hope to give a more complete account of the development hereafter I need only briefly refer to subsequent events. By about the fifth or sixth days the embryo is well-folded off from the large yolk-sac; a day or two later the embryo may be noticed at times to exhibit wriggling movements, and about this time the two developing claspers or suckers begin to show prominently. But neither up till now or at any subsequent stage have I been able to see any trace of external gills, and I believe these are not developed. Gills and tentacular reticulations such as Heron-Royer describes* in *Alytes obstetricans*, if present could hardly be overlooked; moreover external gills are noticeable enough in the newly hatched tadpoles of the species which oviposit in water; hence I am unable to say how respiration is provided for in the early stages unless the tail functions as a respiratory organ. [After a time a single spiraculum is present on the left side as usual. In keeping the tadpoles in aquaria individuals may sometimes be found floating at the surface of the water, the ventral surface uppermost, and every now and then ejecting a number of bubbles of gas sometimes from the mouth and sometimes from the anal aperture, while numbers of small bubbles may sometimes be seen in the spirally coiled intestine; at other times the tadpoles appear to be swallowing air, and often accidentally re-swallow the bubbles previously ejected.

* Bull. Soc. Zool. de France, 1883, p. 423.

These phenomena, may, however, be pathological, as the individuals sometimes seem sickly, and may have nothing to do with respiration; but I have never seen anything like it in tadpoles of other species.] Development proceeds steadily, the tadpoles becoming more and more recognisable, until after between a fortnight or three weeks from the time of laying they are ready for hatching. By this time in order to accommodate itself to the size of the chamber in which it lies the tadpole bends its tail round to one side, the tip reaching to the snout or beyond; from time to time the position is changed by bending the tail the other way. If now a number of the ova are placed in water some of the tadpoles will emerge very shortly, while others may not do so for a day or two. They emerge through a usually more or less circular hole; but I have never been able to observe the actual exit though I have watched for it, and have several times seen them with the tail free, but these may be cases of misadventure. Possibly the tadpole with its horny beaks first weakens a spot in the envelope softened by moisture, and then deliberately increases the strain, as Royer describes in *Alytes* (l.c. p. 428). If the ova do not get into the water the hatching is simply postponed till they do, a proceeding which at any rate for a period of at least three months, provided of course that they are not absolutely deprived of moisture, seems to cause little inconvenience. They can stand a good deal of dessication without damage; and anyone who sees specimens which have undergone some drying up for the first time would hardly believe that the contained tadpoles are still alive; nevertheless on the addition of water the gelatinous matter again swells up as before; under these circumstances if the ova are left in the water the tadpoles seem to hatch more quickly than otherwise.

Balfour in his *Comparative Embryology* (Vol. II. p. 115) mentions the large yolk-sack of *Pseudophryne australis*. This is evidently correlated with the ability to endure a postponement of the hatching. Oviposition takes place after heavy rain, and the next fall of rain has to be depended upon for the release of the

tadpoles; but the intervening period may be one of weeks or months. On July 29th, 1885, I exhibited at a meeting of this Society [*vide* Proceedings x, p. 342] ova of *P. bibronii* (not *P. australis* as there mentioned) obtained in the previous April, that is to say a period of between three and four months, yet the tadpoles seemed to be none the worse; after reaching the condition of readiness for hatching they increased but little in size, and there was a marked difference in this respect between tadpoles of the same batch allowed to hatch at different times. I have not yet ascertained the limit of endurance, but it was certainly not reached in the above case. The only difficulty to be contended with is to keep the ova sufficiently moist and yet keep them free from attacks of moulds. I kept them in the hope of seeing them complete their metamorphoses without gaining access to water; this however they seem unable to do. The tadpoles are very hardy, strikingly so as compared with those of other species. A number of them may be hatched out in a wine-glassful of water and left for a fortnight or longer without the water being changed or any food supplied, and yet they seem none the worse for such treatment which would be fatal to ordinary tadpoles.

The above-mentioned facts explain the sudden appearance of large numbers of the tadpoles in pools and ponds after heavy rains, which when previously visited were dry or contained no tadpoles, and when the intervening interval has been too short to allow development to have reached the stage met with. I have met with instances of this kind frequently, but the tadpoles have always being referable to one or other of the species of *Pseudophryne*; and I have seen nothing to warrant the supposition that the tadpoles of other species by burying themselves in the mud can survive for any length of time if, as frequently happens, the ponds dry before the completion of the metamorphoses; if they could one would expect to find instances of their sudden re-appearance after rain has again filled the ponds. Balfour (l.c. p. 116) also says: "The tadpoles of Toads are the smallest, *Pseudophryne australis* excelling in this respect." When hatched the tadpoles of both species are about 10 mm. long of which the

tail is 7 mm., and the body about 2 mm. broad. They grow pretty rapidly when they are well fed, until they are about 25 mm. long, the body being about 8-10 mm. long and 5-6 mm. broad. They are of a dark colour, blackish, greyish or dark brown, becoming lighter, olive brown, as they grow older, with innumerable minute bronzy specks especially on the ventral surface. The ova and tadpoles of the two species are indistinguishable as far as I can see at present, the larval frogs not acquiring the colours of the adults, but they probably do so very soon after quitting the water, as I have a young specimen of *P. australis* found early in April, about 10 mm. long, which has the characteristic markings. In several instances tadpoles hatched from ova found in April, and kept in an aquarium, completed their metamorphoses in the September following; but this is probably at least twice as long as is necessary under natural conditions.

HYLIDÆ.

11. *HYLA CÆRULEA*, White, sp.

One of our commonest species, but I have never been able to catch the frogs breeding. Two males taken towards the end of January both have breeding rugosities. In the first week in March a number of tadpoles captured a fortnight previously completed their metamorphosis; three of the young frogs, now in spirit, measuring about 17 mm. from snout to vent, and two of them having a few white spots on the back and sides. The pond from which these specimens came was in the middle of a grass paddock, and was periodically visited by me; and I have no doubt that the ova were deposited in water in the ordinary way. This species begins to be seen and heard later even than *H. aurea*; and appears to breed during the summer months. Mr. A. G. Hamilton informs me that at Guntawang in the Mudgee district early in February, on one occasion in a tuft of grass at some little distance from water he found a pair *in coitu*, the embrace being axillary.

12. *HYLA PERONII*, D. & B., sp.

All my specimens have been captured in the post-holes in fences, in which, in one locality when not too dry I could generally (in the

daytime) find at least one specimen asleep—when they are nearly white—from about October to April. Early in December hearing a number croaking in the neighbourhood of a pond, and guided by the croaking I caught a male in a post-hole, with a brown rugosity on the first finger of each hand; judging from the croaking the others appeared to be on the ground but hidden under the banks, and I suspect they were preparing to spawn, and that they do so in the ordinary way. A large tadpole with well-developed hind legs is 61 mm. long of which the body is 21 mm.

13. *HYLA PHYLLOCHROA*, Gthr.

This species is common in shady gullies. During the summer months a few of these frogs may generally be found in Mr. Macleay's bush-house, in the day-time asleep on the plants. On four different occasions, in December (twice), January, and February I have seen a pair *in coitu* in the water-cask used by the gardener in the bush-house. They can only spawn comfortably when the casks are quite full; the female then sits on the bevelled edge of the cask looking outwards with the hind-quarters in the water. The pigmented pole of the ova and the young tadpoles themselves are rather pale yellow, and this will help to distinguish them from the darker yellow prevailing in *H. ewingii* var. *calliscelis*. In the same three months of the following year spawn was again found on three occasions, but I did not happen to find the frogs. Under more natural conditions the spawn is attached to blades of grass, twigs, &c. (as Mr. Hamilton has informed me); and they also spawn earlier than the above dates, as in October last in a gully near Kiama in the day-time my attention was attracted by croaking, and on going to see I found a number of these frogs having a sort of field day at the opening of the breeding season just as I have noticed several times in the case of *H. aurea*; a number of the frogs were in the water, and very active, the males croaking vigorously and every now and then making a grasp at the females. No spawn was visible, but I was unable to visit the spot again.

14. *HYLA DENTATA*, Kef.

A rare frog. I have only taken two specimens and these not full grown. I know nothing of the habits of this species.

15. *HYLA CITROPUS*, P. & L., sp.

Not common. Mr. Krefft gives Ryde and Hunter's Hill as localities. I have not found it nearer than Waterfall; also in the gullies at Mt. Wilson. In September last at Waterfall a pair of this species were found *in coitu* on the damp rocky bed of the creek close to water. They were caught without difficulty and spawned in a dish containing water 24 hours later, the male never relaxing his hold as far as observed. The male has a blackish rugosity on the first finger of each hand.

16. *HYLA EWINGII* var. *CALLISCÆLIS*, Peters.

One of our commonest frogs, whose shrill notes may be heard all the year round when the weather is not too dry. This species probably breeds pretty nearly throughout the year. On June 16th, 1885, under a large stone about a yard from the edge of a pond I took a pair *in coitu*, which allowed themselves to be caught without trouble; the female spawned on the evening of the 19th, the male so far as observed not having relaxed his position on the female's back. The male is much smaller than the female, and has a brownish rugosity on the first finger of each hand. The ova have the pigmented pole orange. Similar ova in bunches attached to twigs, blades of grass, &c., I have found in from May to September, but some of it may have been laid by *H. krefftii*.

What I take to be this species also sometimes (in different years I have noted it in November, December, January and February) spawns in the water-casks under similar conditions to *H. phyllochroa*. The gardener has frequently seen them; I have seen the spawn, but have always been too late to see the frogs themselves; from his description, and from the characters of the spawn there can be I think little doubt about the species. In the middle of November 1885 I found hundreds of advanced tadpoles

in the liquid mud of a pond which was in the last stage of drying up; a week later several of them completed their metamorphoses crawling out of the water up the side of the jar; two of these now in spirit are about 12 mm. from snout to vent.

18. *HYLA KREFFTII*, Gthr.

Not very common about Sydney; have taken specimens on *Zamia* at Randwick early in March; also numerous specimens under logs at Burrawang in July, some of them females distended with ova. Hence this species probably breeds in spring or early summer, but I have not yet been able to obtain any details about the oviposition. On a *Zamia* at Randwick when collecting specimens of this frog with Mr. Masters, pellets of excreta were noticed consisting largely of fragments of the elytra &c. of beetles, whereupon Mr. Masters pointed out to me that two Curculios (*Tranes internatus* and *Epizeuxis lyterioides*) frequent the *Zamias*, so that it seems likely that the Hylas haunt the *Zamias* to feed on these beetles.

19. *HYLA AUREA*, Less., sp.

This species breeds from about the middle of spring through the summer. In three successive years in the same pond about the end of September numbers of this species were noticed in a considerable state of excitement, the males darting at and seizing the females; but little or no spawn was deposited. Early on the morning of October 20th, 1886, in the pits in a disused tan-yard I found a number of couples *in coitu*, as well as a good deal of spawn; the female of a couple which I caught and took home commenced to spawn during the day in a dish of water, and completed the operation some time during the succeeding night, the male never relaxing his hold. In the first week of December of this same year I also found breeding couples. I have noted finding young frogs, which had just about completed their metamorphosis, common about the margin of swamps in December, March and April; and tadpoles at the beginning of April in a pond in which there were also tadpoles of two other species of *Hyla*, one

of them *H. cerulea*, examples of all of which were to be met with in which at least the hind legs were well developed. The larval frogs of this species acquire golden stripes before leaving the water. I have noted as unusually early seeing two specimens of *H. aurea* on the margins of a pond on July 31st, and of hearing and seeing a number on August 20th of the same year.

20. *HYLA LESUEURII*, D. & B.

I have not taken this species nearer than Bulli where it was not uncommon under stones in June. I have also found a few specimens in the gullies at Springwood in January; from the conditions under which these were found this seems to be a terrestrial species diurnal in its habits; the chestnut tinge of the back harmonises with the dead leaves and strips of bark lying about on the ground; so that seeing a good specimen, but taking my eye off for an instant, it was some time before I could recognise it again though it had not moved. This is a common species in the Mudgee district whence I have numerous specimens of various sizes sent me by Mr. Hamilton, and a fine example sent me alive by Mr. J. D. Cox. I have no information at present about the oviposition.

21. *HYLA LATOPALMATA*, Gthr., sp.

Two specimens are in the British Museum from Richmond. I have found only a single specimen which jumped up in front of me while walking across a grass paddock between a swamp and the banks of South Creek at St. Mary's.

22. *HYLA FREYCINETI*, D. & B., sp.

Common about the swamps near the coast from Botany to Narrabeen. Early in August among the reeds in a large pond, vociferous croaking was going on, attracting one's attention even at a distance; a good deal of frothy spawn was visible, but the frogs were too shy and the pond was too full to get near them. The croaking of *Limnodynastes tasmaniensis* was recognisable, but that of the majority of the frogs was new to me, and I suspect

them to have been *H. freycineti*. In the middle of last April I found a number of tadpoles just about completing their metamorphoses, about 35 mm. long, the body 15 × 7 mm. Towards the end of March in the previous year numbers of young frogs which had only recently taken to land were common about the edges of swamps at Botany. Three males taken as late as the beginning of April have a brownish rugosity on the first finger of each hand. There can I think be little doubt that this species breeds in spring and summer, and oviposits in water in the ordinary way. This species may possibly hibernate buried in the mud, as unless the frogs travel some distance in some localities there is a dearth of suitable shelter.

23. *HYLA DIMOLOPS*, Cope.

This species, mentioned in the British Museum Catalogue as from Sydney, I have never met with.

24. *HYLELLA BICOLOR*, Gr., sp.

I have never met with this frog. Krefft gives as localities "30 miles from Sydney, and Blue Mts." In Professor Parker's third memoir "On the Development of the Skull of the Batrachia" (*Phil. Trans.* 1881, p. 158) the locality Dogtrap Road, Parramatta is mentioned for it.

In regard to the foregoing list the following points may be noticed:—*Limnodynastes ornatus* occurs in Keferstein's list* under the two names *Platyplectrum marmoratum* and *P. ornatum*, for each of which the locality Sydney is given. In Steindachner's list † Sydney is given as a locality for *Cryptotis brevis*. I have specimens of the former from Mudgee collected by Mr. A. G. Hamilton, and I have found examples of the latter in gullies in the Blue Mts.; but I have not found them in the County of Cumberland nor have I met with any who has. These two, and a similar remark possibly applies to *Helioporus albo-*

* "Ueber die Batrachier Australiens," Arch. f. Naturgesch. 1868; Bd. i, p. 253.

† "Reise der Novara," Amphibien.

punctatus and *Crinia georgiana*, are either rarer than they used to be since resident collectors do not find them, or, what is perhaps more probable, the earlier collectors of frogs used the term Sydney in a similar somewhat elastic sense to that in which the early botanical collectors are known to have used the term Port Jackson. Dr. Keferstein was indebted to Mr. Krefft for some of his material; but it is noteworthy that though Krefft's latest list was published about two years later than Keferstein's paper, yet the former does not give Sydney as a locality for *L. ornatus*; nor indeed for any of the other species in question, nor for *L. salminii*. If we except *Crinia georgiana*, this is not a matter of much importance, as the others undoubtedly occur in New South Wales. But, as far as I can learn, the British Museum specimens of *Crinia georgiana*, which were acquired by purchase, are the only specimens recorded from New South Wales, and in this colony from Sydney only; in which case, and if the collector did not mix his specimens, it is remarkable that it should not have been again found here.

Mr. Krefft frequently refers to *Hyla verreauxii*, a name which does not occur at all in Mr. Boulenger's Catalogue, but which he tells me in a letter was unintentionally omitted, and that it is probably a variety of *H. ewingii*. From Mr. Krefft's remarks about it I suspect that he refers to the frog now known as *H. ewingii* var. *calliscelis*.